International Cognitive Visualization

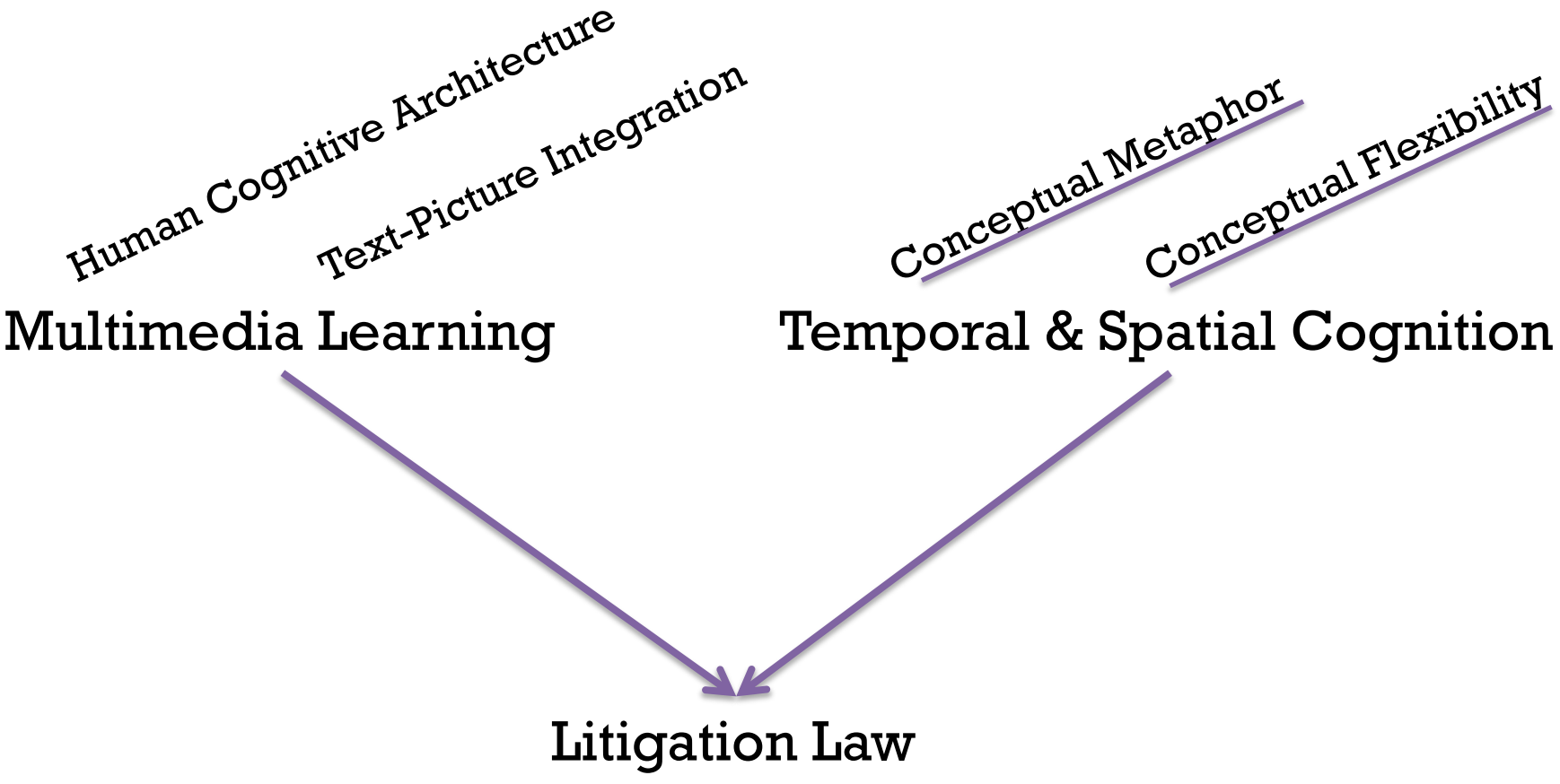
Thesis Defense for Amy Rae Fox

Visualizing Time

The Influence of Timeline Axis and Direction on Causal Reasoning in Litigation Law

- Introduction & Literature Review
- Methodology
- Results & Discussion

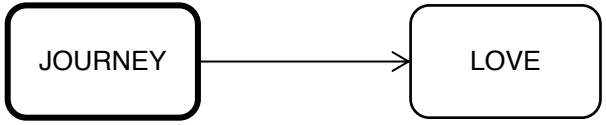
Introduction


Human Cognitive Architecture
Text-Picture Integration
Conceptual Metaphor
Conceptual Flexibility
Multimedia Learning
Temporal & Spatial Cognition
Litigation Law

How do we { think / reason / learn } about abstract concepts?

LOVE is a JOURNEY

Look how far we've come.
It's been a long, bumpy road.
We can't turn back now. We're at a crossroads.
We may have to go our separate ways.
The relationship isn't going anywhere.
We're spinning our wheels.
Our relationship is off the track.
The marriage is on the rocks.
We may have to bail out of this relationship.

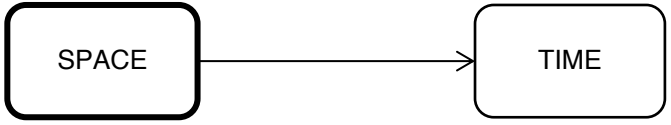


Travellers	*are*	the lovers
A vehicle	*is*	the relationship
Destinations	*are*	the lovers' common goals
Obstacles	*are*	relationship difficulties

Lakoff, G., & Johnson, M. (1980). Metaphors We Live By. Chicago: University of Chicago Press. doi:978-0226468013

Lakoff, G. (1992). The Contemporary Theory of Metaphor. In A. Ortony (Ed.), Metahpor and Thought (Vol. 2, pp. 1–47). Cambridge University Press.

TIME is SPACE



- In language
- In gesture
- In drawing
- Psycholinguistic experiments

Inter-cultural variation | Inter-individual variation | Intra-individual variation

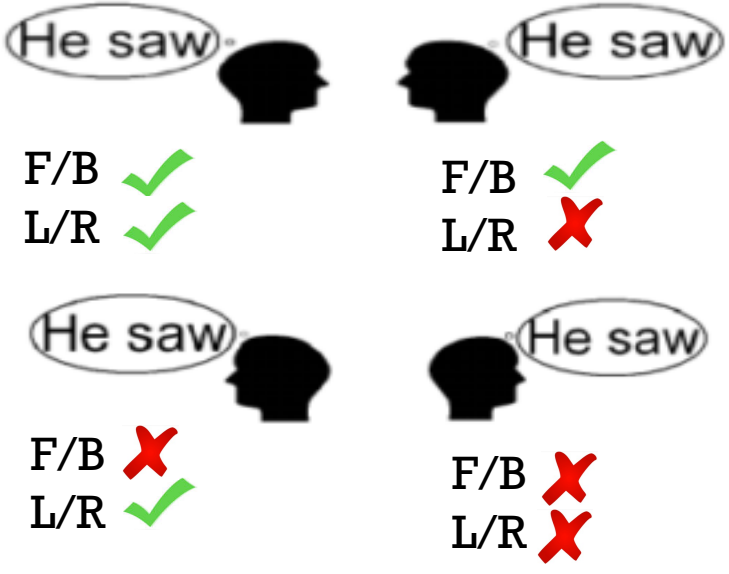
Introduction > Conceptual Metaphor

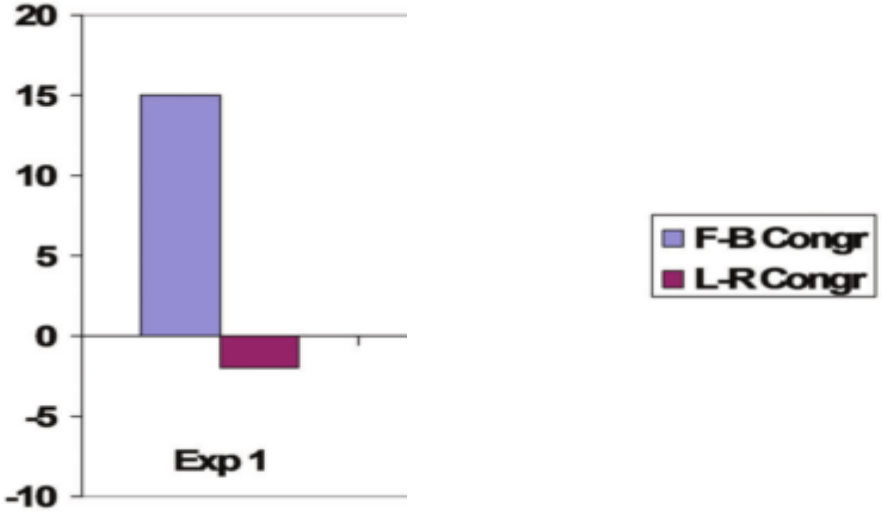
		Spatial construal		Methods	Spatial reference	Linguistic metaphors	Notes
Group 1[a]	English	DT[INT c.cf]:	*past*: back; *future*: front	GES-S [84], PSY-L [81–83]	egocentric [96]	past behind ego, future in front; later events behind earlier events; duration can be long/ short [6]	*writing:* L-to-R; *other tech:* L-to-R timelines and calendars; for similar patterns, see also: German [83], Italian [12]
		DT[EXT]:	*past*: left; *future*: right	ARRG [56], GES-E [55], GES-S [84]; PSY-L [46]			
		ST:	*earlier*: left; *later*: right	ARRG [56,57], GES-E [55], GES-S [84], PSY-L [46, 94], PSY-N [68,95]			
		TS:	*duration*: extent	PSY-N [70]			
	Greek	TS:	*duration*: amount	PSY-N [51]	egocentric*	duration can be large/ small [51]	see also: Indonesian [51]
	Hebrew	DT[EXT]:	*past*: right; *future*: left	ARRG [68]	egocentric*	*	*writing:* R-to-L; *other tech:* *
		ST:	*earlier*: left; *later*: right	ARRG [57,68], PSY-N [68]			
	Mandarin	DT[EXT]:	*past*: up; *future*: down	GES-E [55], PSY-N [55]	egocentric*	past up, future down (only on some time scales) [55]	*writing:* T-to-B; L-to-R; *other tech:* * for comparison, see: Taiwanese [58], Cantonese [59]
			past: left; *future*: right	GES-E [55], PSY [55]			
		ST:	*earlier*: up; *later*: down	ARRG [58], GES-E [55], PSY-N [55,95,97]			
			earlier: left; *later*: right	ARRG [58], GES-E [55], PSY-N [55,95,97]			
	Spanish	DT[INT]:	*past*: back; *future*: front	GES-S [24]	egocentric*	past behind ego, future in front; later events behind earlier events [24]	*writing:* L-to-R; *other tech:* L-to-R timelines and calendars
		DT[EXT]:	*past*: left; *future*: right	PSY-L [74,75]			
		ST	*earlier*: left; *later*: right	PSY-N [76]			
Group 2[b]	Aymara	DT[INT]:	*past*: front; *future*: back	GES-S [24]	mixed [60]	past in front of ego, future behind	*writing:* none attested; *other tech:* none attested
	Pormpurraw	DT[EXT]:	*past*: east; *future*: west	ARRG [56]	geocentric [48]	none attested	*writing:* none attested; *other tech:* none attested
		ST:	*earlier*: east; *later*: west	ARRG [56]			
	Yupno	DT[INT]:	*past*: downhill; *future*: uphill	GES-S [24]	geocentric [98]	limited expressions attesting past downhill, future uphill [49]	*writing:* none attested; *other tech:* none attested

Núñez, & Cooperrider. (2013). The tangle of space and time in human cognition. *Trends in Cognitive Sciences*, *17*(5), 220–9. doi:10.1016/j.tics.2013.03.008

How do individuals choose which metaphor to activate in a given context ?

Is the person thinking about the future or the past?





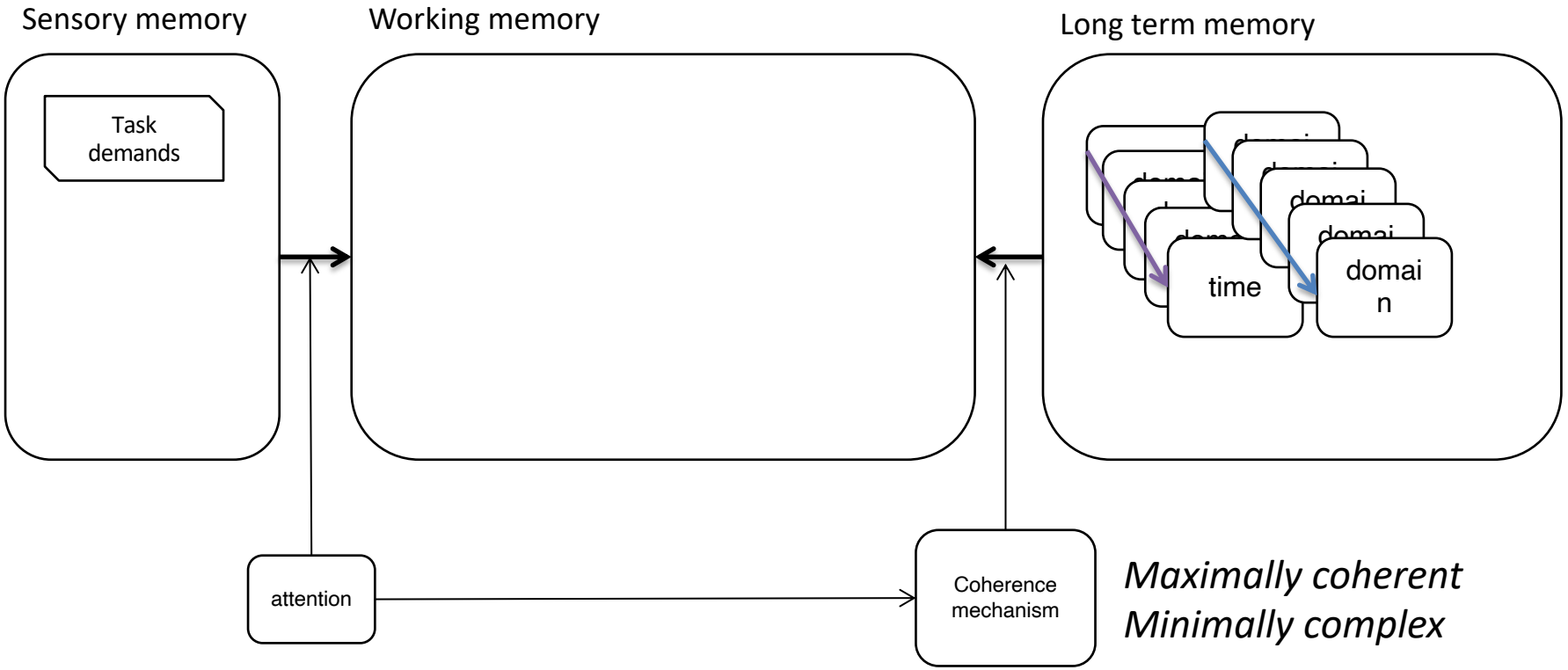
Comparison of congruency effects on response latency

Experiment 1: Respond vocally (past, future)

Experiment 2: Respond with left/right key press (past, future)

Torralbo, A., Santiago, J., & Lupiáñez, J. (2006). Flexible conceptual projection of time onto spatial frames of reference. Cognitive Science, 30(4), 745–57.

Introduction > Coherent Working Models Theory



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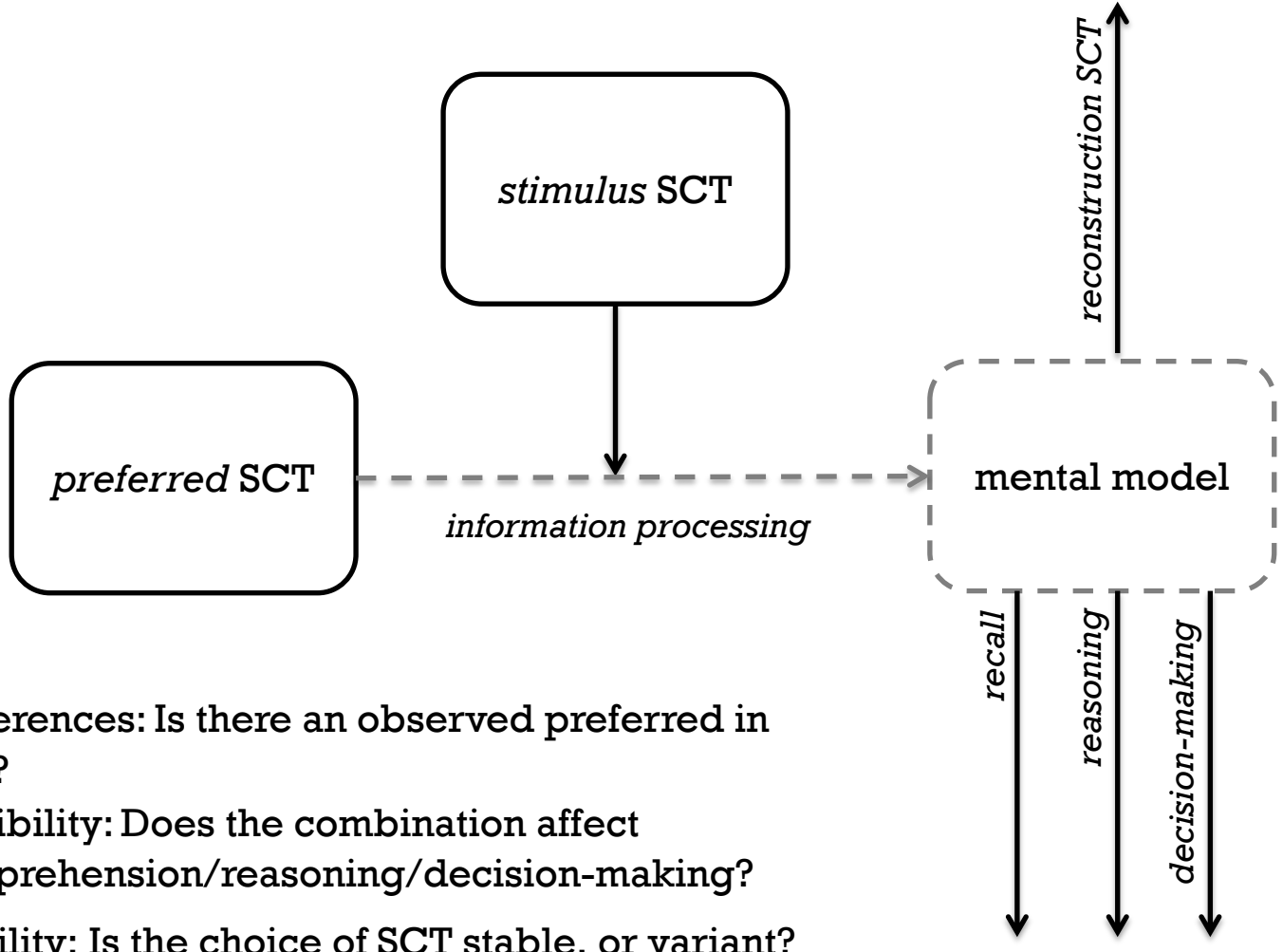
1. Preferences for SCTs
   Replicate previous research on the relationship between SCTs and reading/writing direction (RWD), with computer-based stimuli.

2. Flexibility in SCTs
   Test hypotheses derived from the Coherent Working Models Theory about the construction of mental models from inconsistent SCTs, and subsequent reasoning and decision-making.

3. Stability in SCTs
   Explore the stability of SCT preferences and potential impacts on mental model construction.



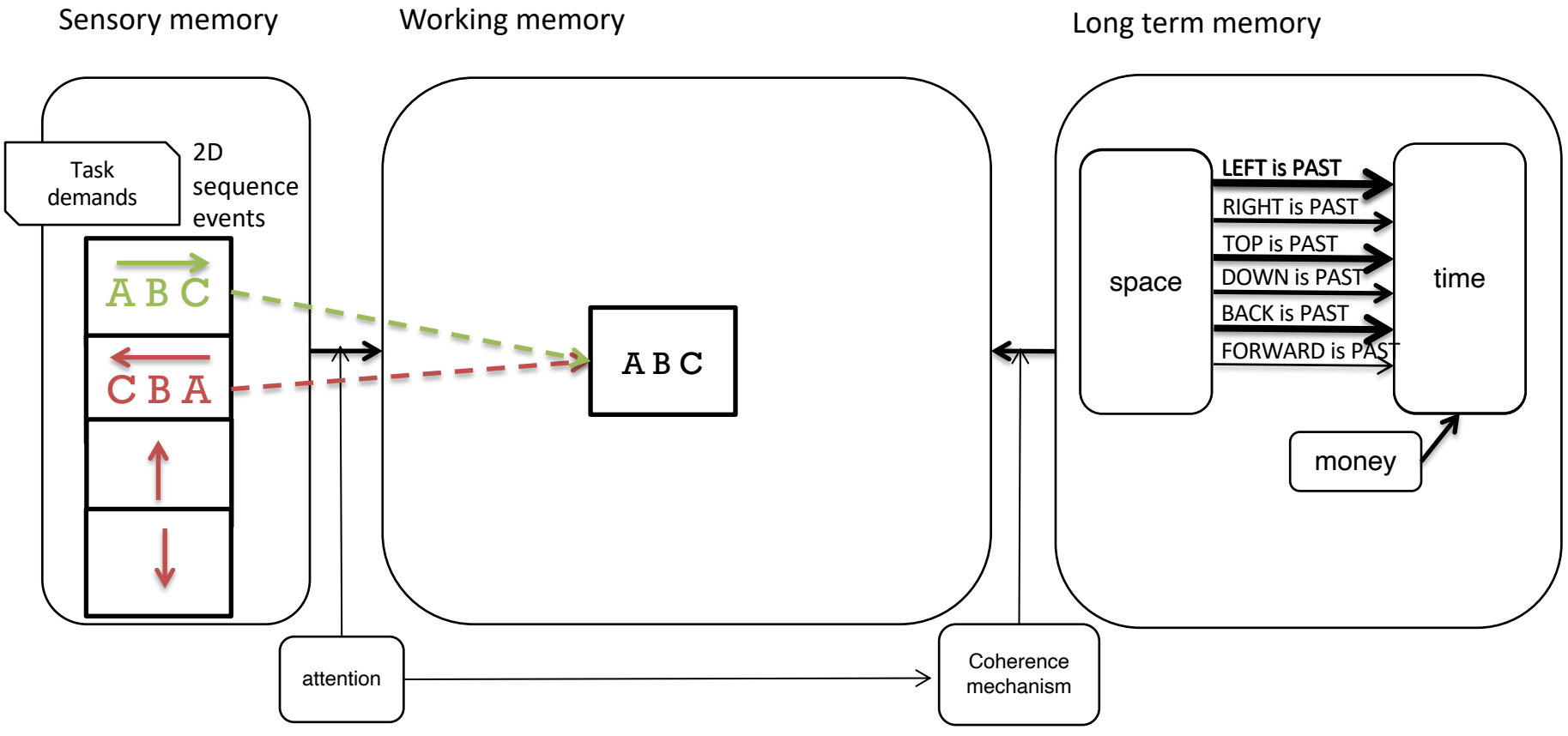
Preferences: Is there an observed preferred in SCT?

Flexibility: Does the combination affect comprehension/reasoning/decision-making?

Stability: Is the choice of SCT stable, or variant?

Can the visual-spatial representation of a temporal sequence influence comprehension, causal reasoning and decision-making in litigation law?

Introduction > Hypotheses



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In an English speaking population :

(H1) Participants will select a SCT consistent with RWD (Left-to-Right) when asked to construct a timeline on a two dimensional plane.

(H2) After a stimulus presentation and brief delay, participants will again select a SCT consistent with RWD when asked to construct a timeline.

When compared to a control group (Stimulus SCT = Left-to-Right), participants presented with alternatively oriented timelines (Right-to-Left, Top-to-Bottom, Bottom-to-Top) will:

(H3) … make more errors in recalling details of the case.
(H4) … make more errors in reasoning about details of the case.
(H5) … have less confidence in their verdict.
(H6) … be less likely to find a defendant culpable.

Methodology

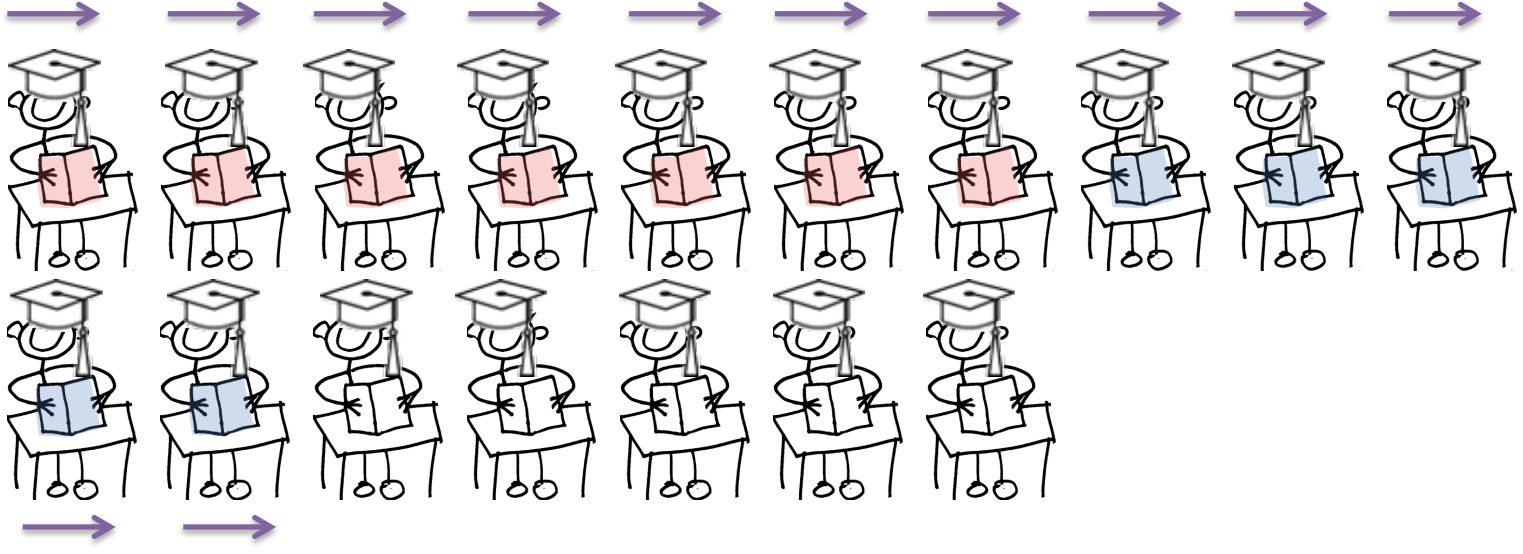
Methodology > Design

2 X 2 factorial
Timeline Axis (horizontal, vertical) x Consistency with RWD (consistent, inconsistent)

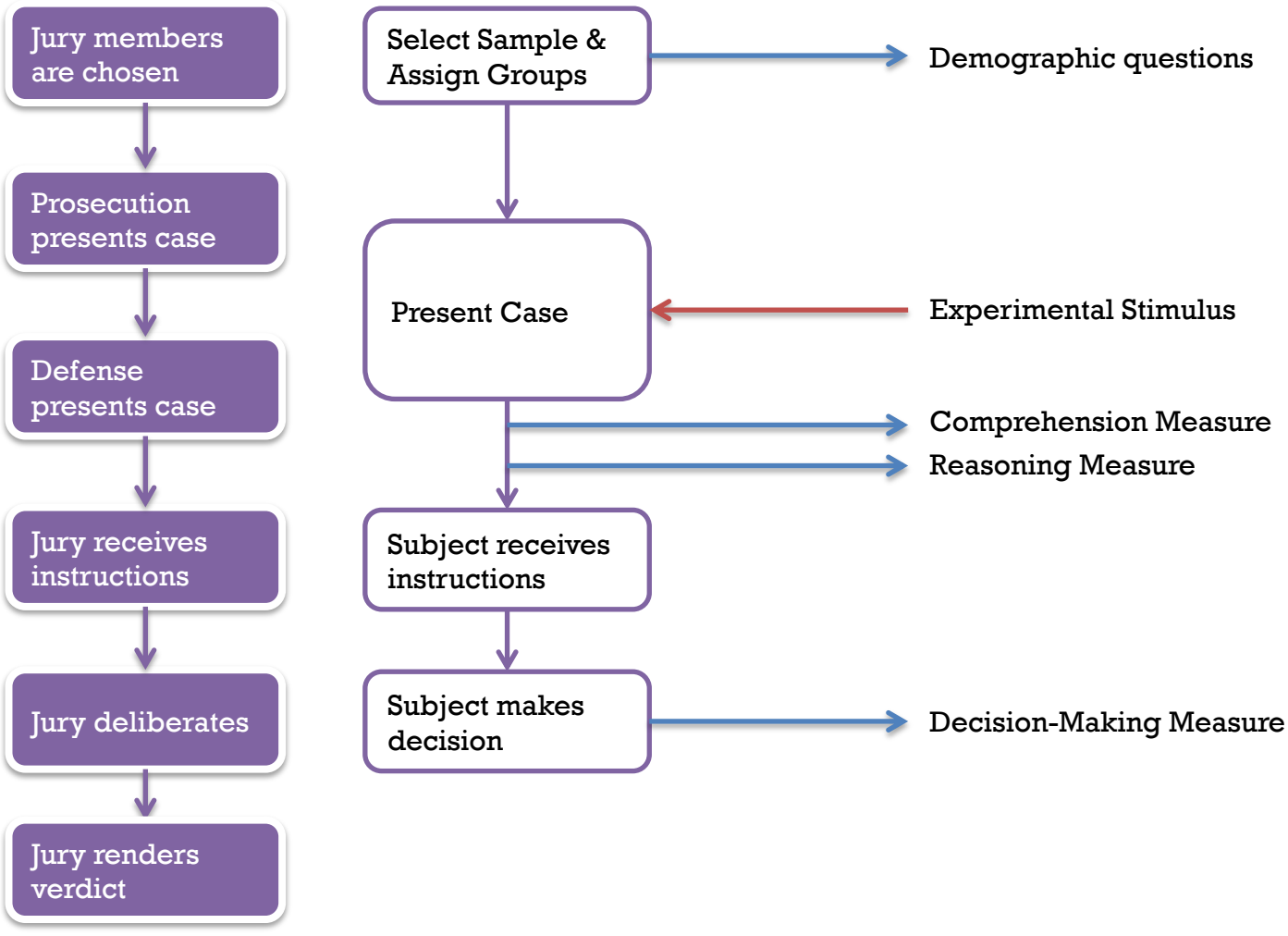
		Axis	
		Horizontal	Vertical
Direction	RWD Consistent	→ Left-to-Right	Top-to-Bottom ↓
	RWD Inconsistent	← Right-to-Left	Bottom-to-Top ↑

Methodology > Sample

n= 116 (64% female, median = 21)



Methodology > Procedure



Results

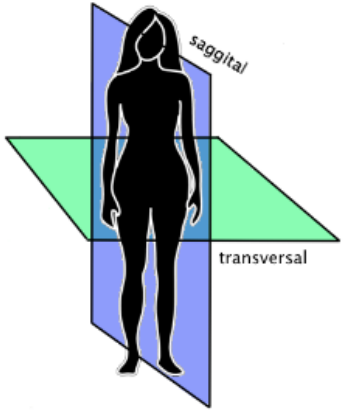
Results > Overview

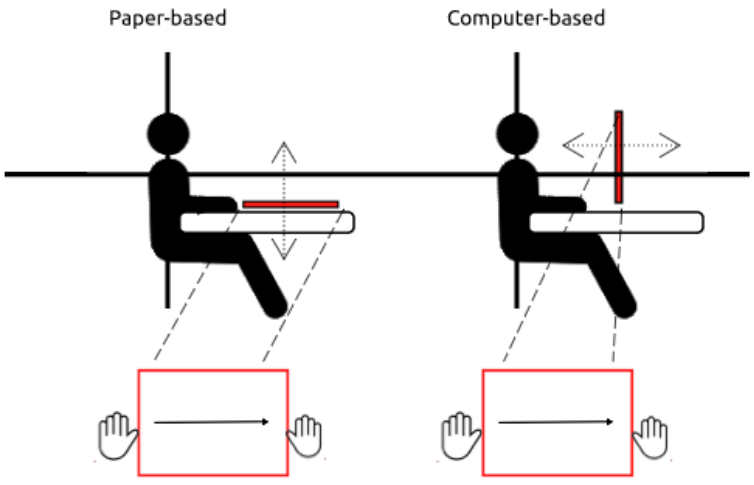
Hypothesis		Result	
In an English-speaking population:			
H1	Participants will select a SCT consistent with RWD (Left-to-Right) when asked to construct a timeline on a two dimensional plane.	✓	76% of participants selected SCT_1 of Left-to-Right.
H2	After a stimulus presentation and brief delay, participants will again select a SCT consistent with RWD when asked to construct a timeline.	✓	84% of participants selected SCT_2 of Left-to-Right, despite receiving a different stimulus SCT.
When compared to a control group (Stimulus SCT = Left-to-Right), participants presented with alternatively oriented timelines (Right-to-Left, Top-to-Bottom, Bottom-to-Top) will:			
H3	…make more errors in recalling details of the case	7	… made *fewer* errors in comprehension.
H4	…make more errors in reasoning about details of the case	7	… not significantly differ in reasoning.
H5	…have less confidence in their verdict.	7	… not significantly differ in confidence.
H6	…be less likely to find a defendant culpable.	7	… not significantly differ in culpability.

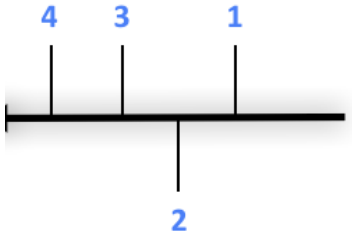
Results > **Preferences** for SCTs

H1 Participants will select a SCT consistent with RWD (Left-to-Right) when asked to construct a timeline on a two dimensional plane

✓ 76% of participants selected SCT_1 of Left-to-Right.







2%

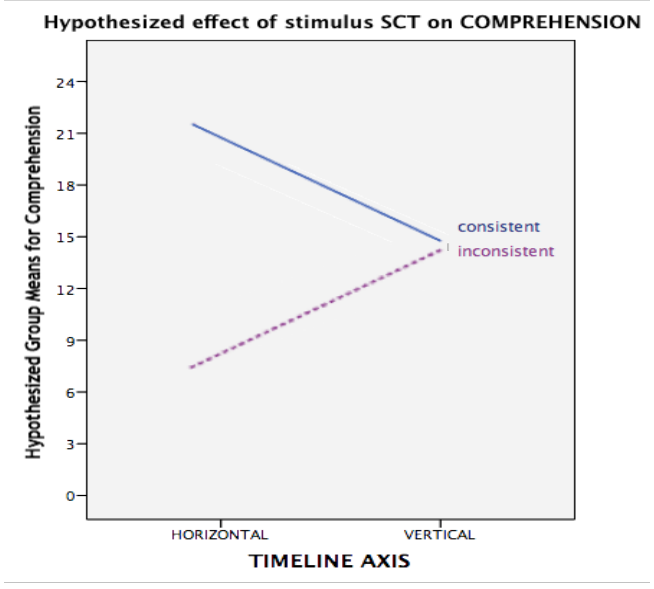
> *Replicates (Tversky et al., 1991) showing preference for RWD consistent SCTs with computer-based stimuli in an adult population*

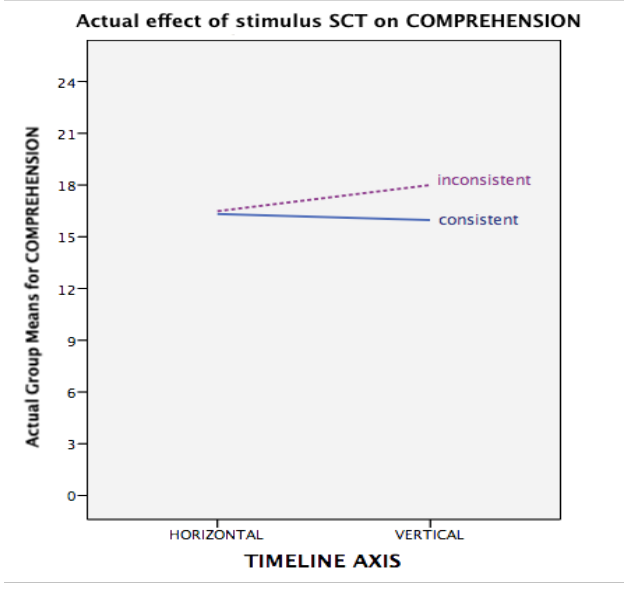
Tversky, B., Kugelmass, S., & Winter, A. (1991). Cross-cultural and developmental trends in graphic productions. *Cognitive Psychology*, *23*, 515–557.

Results > **Flexibility** in SCTs

H3 Participants presented with alternative SCTs will make more errors in recalling details of the case

✗ *… made fewer errors in comprehension.*





> *Effect in opposite direction of hypothesis*

> *Reconsider role of attention as coherence seeking mechanism*

Results > **Flexibility** in SCTs

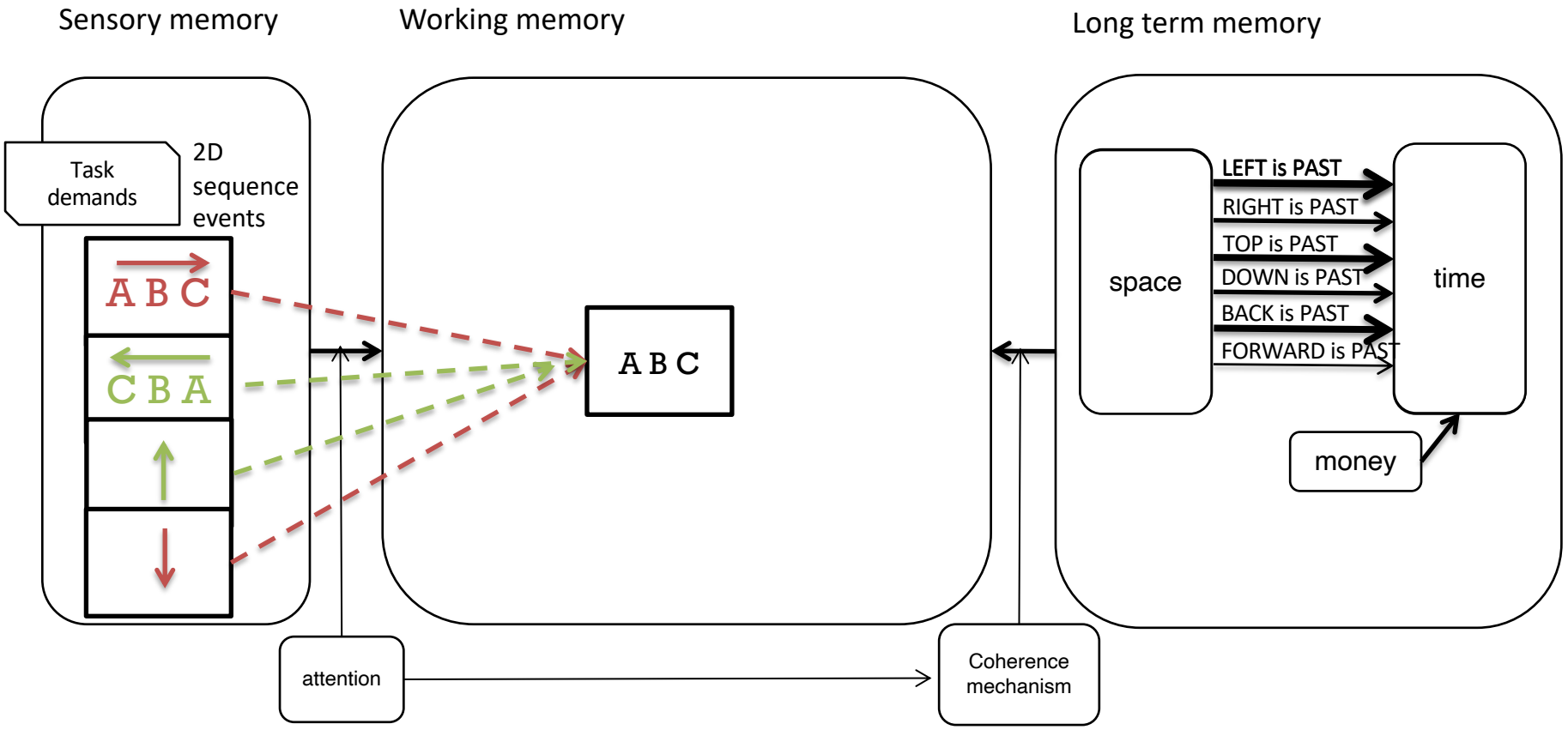
H4 Participants presented with alternative SCTs will …
make **more** errors in reasoning about details of the case

✗ *… no significant differences between groups.*

> *Actual correlations between comprehension & reasoning scores were low* ($r = .273$, $p < .001$)

> *The complexity of the task may have resulted in <u>modification</u> of the individual's mental model*

Introduction > Coherent Working Models Theory



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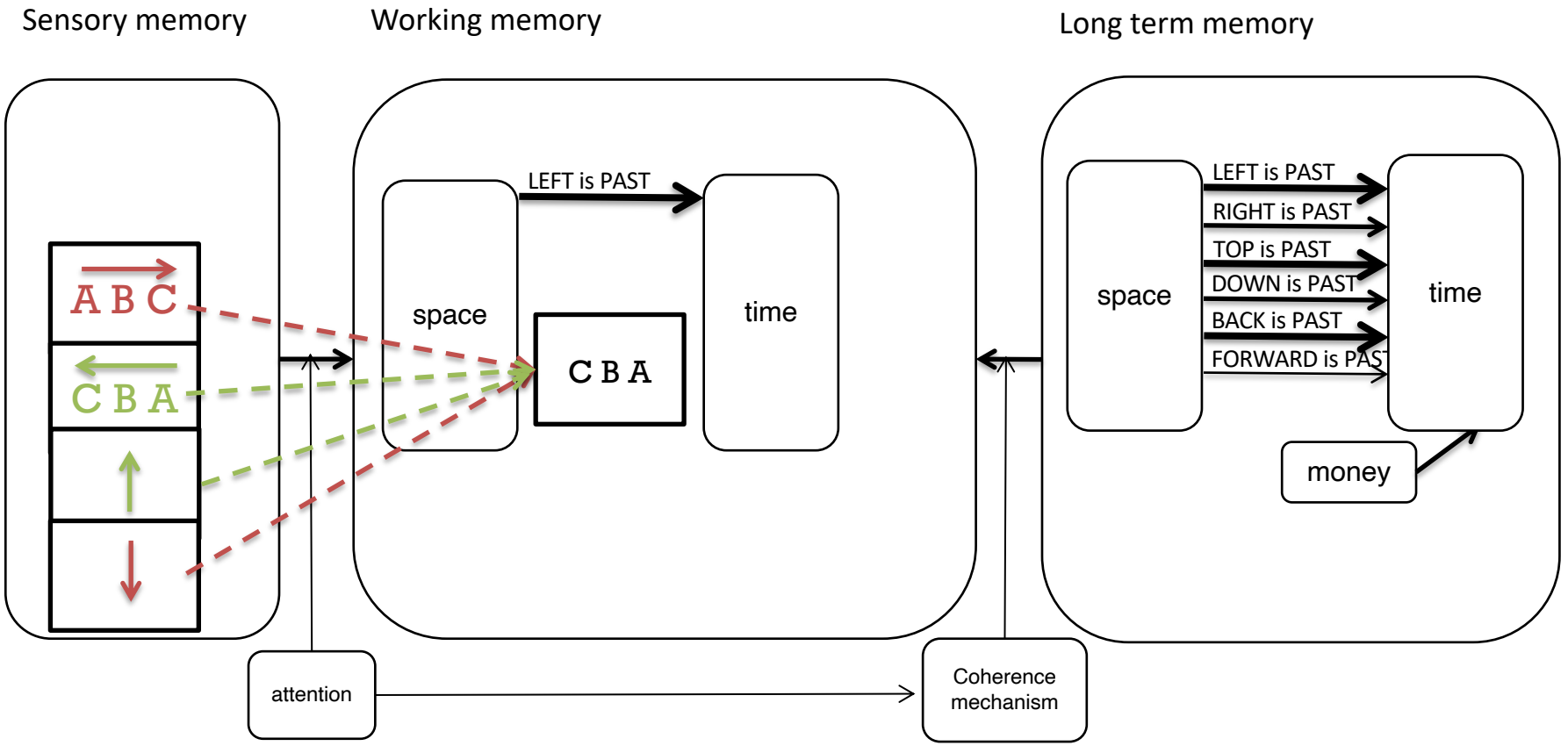
Introduction > Coherent Working Models Theory



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Results > **Flexibility** in SCTs

H5 Participants presented with alternative SCTs will …
have **less** confidence in their verdict.

✗ *… no significant differences between groups.*

> *No significant correlations between comprehension/reasoning and confidence, for any experimental group*

> *What other factors may strongly influence meta-cognition?*

Results > **Flexibility** in SCTs

H6 Participants presented with alternative SCTs will …
be **less likely** to find the defendant culpable

✗ *… no significant differences between groups.*

> *No significant differences in culpability findings between groups.*

> *Follows from confidence findings*

> *Recommend modification of the measure to capture threshold of certainty*

Results > **Stability** in SCTs

H2 After a stimulus presentation and brief delay, participants will again select a SCT consistent with RWD when asked to construct a timeline.

✓ 84% of participants selected SCT_2 of Left-to-Right, despite receiving a different stimulus SCT.

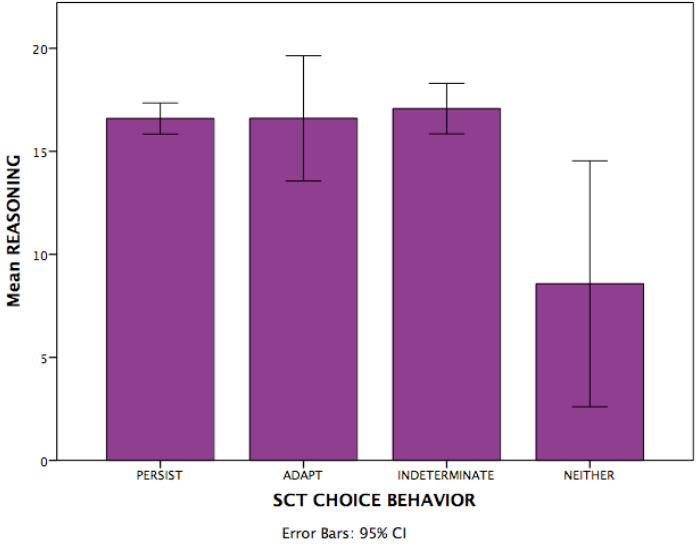
61 % persist

24 % indeterminate

9 % adapt

6 % neither

Stimulus SCT	SCT_2: LR	TB	RL	BT
LR	28		2	1
TB	25	5		
RL	26	1	3	1
BT	20	2		2



> *Seems to be preferable to transform incoming information into a familiar format for representation*

> *Is performance better?*

External validity
> Point of view & one-sided argument
> Sample did not reflect target population
> Length of exposure
> Jury deliberation & external aids

Complexity of case
> Exceeds expectations of participant motivation?

Stimulus exposure time

Measures
> Reasoning measure too long/complex to capture mental model without encouraging manipulation
> Verdict measure failed to capture threshold of certainty

> Control allocation of attention by reducing case complexity (5, 10, 15, 20 events)

> Compare causal and non-causal sequences

> Introduce second stimulus (prosecution vs. defense)

> Do the same patterns in flexibility exist for axes on which RWD does not operate?

Individuals prefer RWD consistent SCTs for computer-based 2-D representations of temporal sequence

Performance on a complex comprehension task was *better* when information was presented in a RWD inconsistent direction

Preference for SCTs was consistent through sequential representational tasks

Performance on reasoning task was impaired when individuals chose to introduce a third SCT

{ THANK YOU
VIELEN DANK
MERCI BEAUCOUP }

	Axis Direction	Horizontal Consistent *Left-to-Right*		Horizontal Inconsistent *Right-to-Left*		Vertical Consistent *Top-to-Bottom*		Vertical Inconsistent *Bottom-to-Top*	
Measure	*Range*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Comprehension	0 - 25	16.32	.66	16.48	.53	15.97	.47	18.00	.47
Reasoning	0 - 25	16.10	.84	15.26	.67	17.07	.65	16.58	.81
% Plaintiff Responsibility	0 - 100	52.74	3.48	57.32	2.99	61.27	3.49	57.25	4.68
Confidence	0 - 100	74.16	3.54	79.13	2.62	78.73	2.97	72.83	3.24
Runtime (minutes)	0 - 60	42.81	1.41	43.04	1.45	41.66	1.01	44.16	1.70
Participants		*n* = 31		*n* = 31		*n* = 30		*n* = 24	